LANDSLIDES WITHIN THE STAVNIC CATCHMENT

Puflea Suzana – Mirela[1]

Abstract: Located in the Central Moldavian Plateau the Stavnic catchment is 21,340 ha in area and is drained by a left tributary of the Bârlad River in length of 53 km. This area shows a high favorability to the land degradation processes (erosion and mass movements) that represents a major threat to the environment.Soil erosion is omnipresent, but landslides are the most important degradation process with significant impact on the evolution and changing of the natural environment configuration, through the damages caused and the affected areas.Based on the field and laboratory data (office) it was noticed that landslides covers 56% of the Stavnic catchment, respectively 12,006 ha. Most of the landslides (97%) are stabilized and the active ones represent almost exclusively reactivation of the old diluvium, and occupy a small area.

Keywords: *Central Moldavian Plateau, land degradation, landslides*

1. Introduction

The most representative geomorphological process which affects the land from the study area is represented by landslides, which "*are natural movement of the rock masses on slopes, involving water under the action of gravity*" (*Donisă I., Boboc N., Ioniţă I., 2009*).

Generally, the evolution and the extent of degradation processes in the Moldavian Plateau is triggered by the combined action of the natural factors (geological, geomorphological, hydro-climatic) and the anthropogenic influence (*Bacăuanu V. et al., 1980*).

The catchment of the Stavnic River is located in the central part of the Central Moldavian Plateau, and occupies 5.8% of the total area, namely 21,340 ha. Northwards, it is confined by the Coasta Iaşilor. Eastwards, it is bounded by the Rebricea catchment and westwards by the Şacovăţ catchment. The Stavnic River springs from Grindeiului Hill, downstream of Pădureni village, Iaşi County and it merges the Bârlad River south of Parpaniţa village. The Stavnic River crosses over the territory of Mădârjac, Horleşti, Voineşti, Mogoşeşti, Mironeasa, Şcheia, Ipatele, Grajduri (Iaşi County) and Rebricea, Negreşti, Vultureşti villages (Vaslui County).

In this typical hilly area the clayey-sandy Miocene layers belonging to the Middle Sarmatian (Bessarabian) and Upper Sarmatian (Chersonian) have outcropped due to erosion. In addition, the recent Quaternary formations are mentioned. The Bessarabian occurs extended, while the Chersonian is discontinuous, only on some hilltops, in the shape of erosion remnants (*Jeanrenaud P., 1961, 1971, 1995*).

In terms of altitude, the mean value of the relief is 225 m with the peak of 450 m in the Teiului Hill – Poiana Mănăstirii and the minimum altitude of 114 m in the Stavnic floodplain.

[1] Universitatea „Al.I.Cuza" Iaşi, Facultatea de Geografie şi Geologie, Departamentul de Geografie, Bd.Carol I 20A, 700505, Iaşi, România, mirela_23may@yahoo.com

The local topography is typical hilly one, peculiar to the Central Moldavian Plateau, where three main relief types are imposed, respectively: the sculptural (fluvio-denudational) topography in general monocline structure (72% of the Stavnic catchment), followed by depositional (23%) and structural-lithological landforms (5%).

The structural relief is firstly associated to the structural – lithological plateaus and secondly to different valley types developed within the monocline structure. The structural – lithological plateaus are situated on some larger extended hilltops by outcropping of the resistant caprock, such as the Repedea oolitic limestone and Șcheia sandstones by Bessarabian age.

The typical landform consists in the relief of cuestas, in association with the development of consequent and subsequent valleys, which highlights the double structural asymmetry in the entire Moldavian Plateau as it has been pointed out by Ioniță I. (1998, 2000a).

Downstream of Hadâmbu village, in the middle and lower reaches, the Stavnic Valley is a consequent one since it is southwards orientated. In the upper catchment, between Hadâmbu and Schitu Stavnic, the Stavnic Valley is oblique orientated, on NW – SE direction and displaying a diagonal subsequent reach. Upstream of Schitul Stavnic, the Stavnic Valley is typical subsequent being transversally orientated on west – east direction.

Under these circumstances, the right valley-side is an ample cuesta front NNE facing, while the left valley-side represents a cuesta backslope SSW looking and it is split by reconsequent tributaries. The valleys of those tributaries emphasize the second order structural asymmetry, where the left side is a typical western facing cuesta front, and the right slope imposes as eastern looking cuesta backslope. Therefore, those reconsequent valleys exhibit at their turn asymmetrical cross-sections.

The scarcity of the valleys with symmetric cross-section is explained by Ioniţă I. (1998, 2000a) through the narrow area, corresponding to the "*monocline resultant*" of the two dipping systems: north - south of 6 -7 m/km and west - east of 3 m/km. The eastward dipping is induced by the more intense tectonic uplifting of the Moldavian Plateau at the contact with the Carpathian Orogen.

The local climate is temperate-continental with shades of excessiveness due to the high values of the thermic amplitude and the irregular distribution of rainfalls. The data recorded over the period 1961 - 2007, provided by the Moldova Regional Meteorological Centre, shows the average precipitation amounts of 530.79 mm yr^{-1} at Vaslui, of 577.02 mm yr^{-1} at Iaşi and 779.6 mm yr^{-1} at Bârnova station. The average annual temperatures are 9.6°C at Iaşi, 9.5°C at Vaslui and 8.3°C at Bârnova weather stations.

Another important control factor in triggering landslides is the human factor. The improper land use and exploitation of the agricultural land, the uncontrolled deforestation, the expansion of settlements and inadequate road network resulted in intensifying of the land degradation processes.

2. Material and methods

The identification and delimitation of areas affected by landslides, including landslides distribution in the Stavnic catchment map were made through the correlation of the field observations, geomorphological mapping and analysis of the orthophotoplans from 2005. Concomitantly, during the first stage, the digital elevation model (DEM) was accomplished by using the TNT Mips software. That model has been obtained by the vectorization of the topographical maps at scale 1:5,000. Afterwards, by means of the DEM, a series of thematic maps have resulted (slope map, shape map and shading map) and classified through the SML language.

Also, the geological map of the study area was processed after "*Geological map of the Central Moldova between Siret and Prut*" delivered by *Jeanrenaud P.* (*1961, 1971*).

The climate maps resulted through the processing of climate data collected between 1961 – 2007 by the Moldova Regional Meteorological Centre, and provided in the CEEX 756/2006 contract entitled "*The impact of hydro-climate and pedo-geomorphological risks on environment in the Bârlad basin*", coordinated by Rusu C.

3. Results and discussions

The area occupied by landslides is very impressive, namely 12,006 ha which represents 56% of the Stavnic catchment (Figure 1). The marked extension of the landslides is closely linked primarily to the natural conditions, such as: the presence of a typical hilly relief, the prevailing alternation of permeable and impermeable rocks (clays, sands, loess-like deposits), the unrolling of wetter periods (especially in the Upper Pleistocene and in the Atlantic-Holocene), the sequence of freeze and thaw cycles, the relative wealth of underground water etc. Secondly, it is mentioned the anthropic factor, mostly the changes of the local landscape occurred during the last two centuries.

However, it should be noticed that the forest still holds today a considerable weight of 39% in the Stavnic catchment.

Most of the landslides are stabilized and occupies 11,624ha (96.8% of total), while the active ones covers only 382 ha (3.2% of total) as shown in the Table no. 1.

Table no.1 The area covered by landslides in the Stavnic catchment

Landslide type	**The area occupied by landslides**		
	ha	% of the area of the basin	% of total landslide
Stabilized	11,624	54.5	96.8
Active	382	1.8	3.2
Total	**12,006**	**56.3**	**100.0**

One mention must be made, that the active landslides had a much greater extension even during the last century, mainly after the precipitation peak recorded between 1968 – 1973 (*Ioniţă I., 2000b*). Since summer 1982, in the context of climate aridisation, many active landslides have turned stabilized.

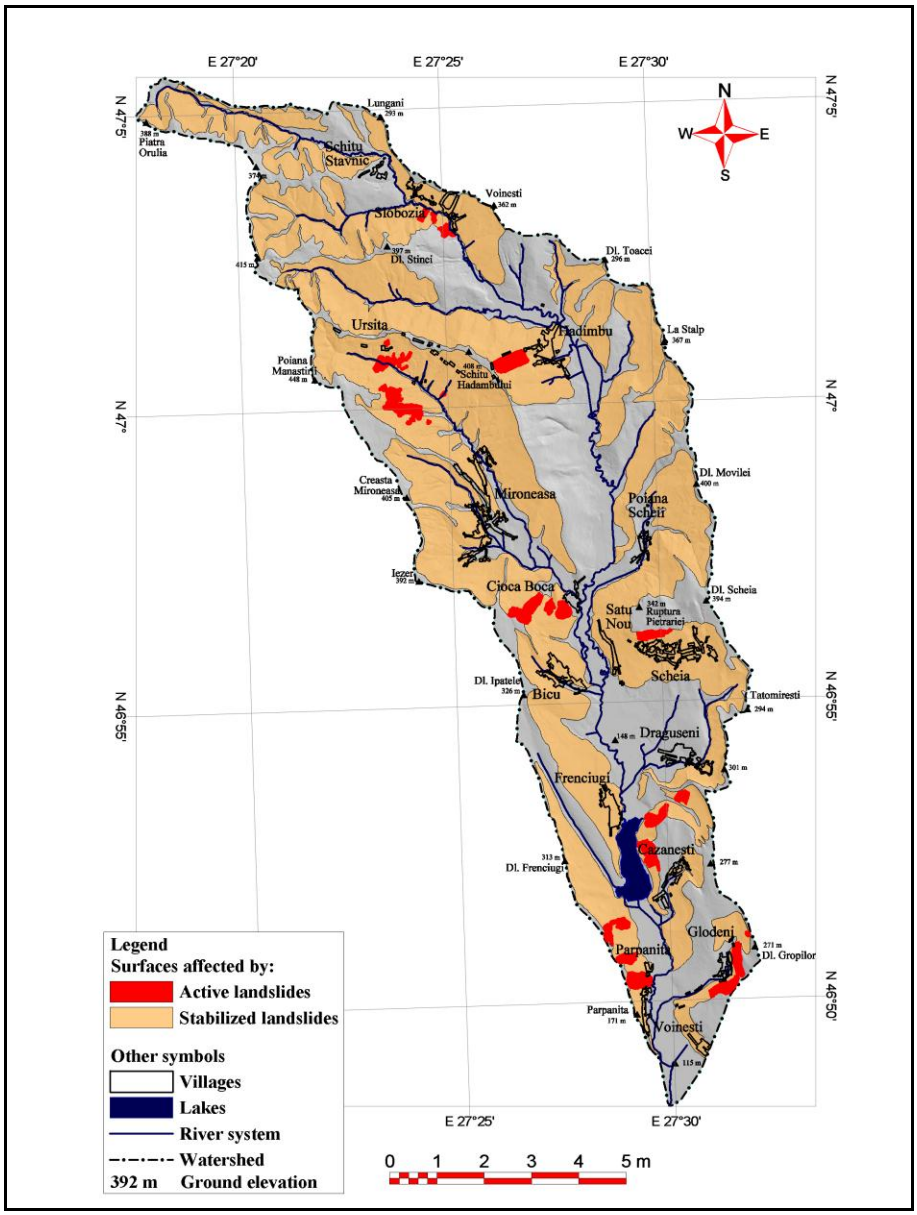

Figure 1: Landslides distribution in the Stavnic catchment

Morphologically, the waves-like shape landslides are prevailing, followed by steps-like ones and the complex landslides.

As to the relation with the altitude it was noticed that the majority of the landslides develop on land between 150 - 350 m a.s.l., respectively 89% of the stabilized landslides and 93% of the active landslides (Figure 2). The reduced share of the landslides between 350-450 m is mainly connected to the extent of structural-lithological plateaus, developed on the Bessarabian sandstone-limestone caprock.

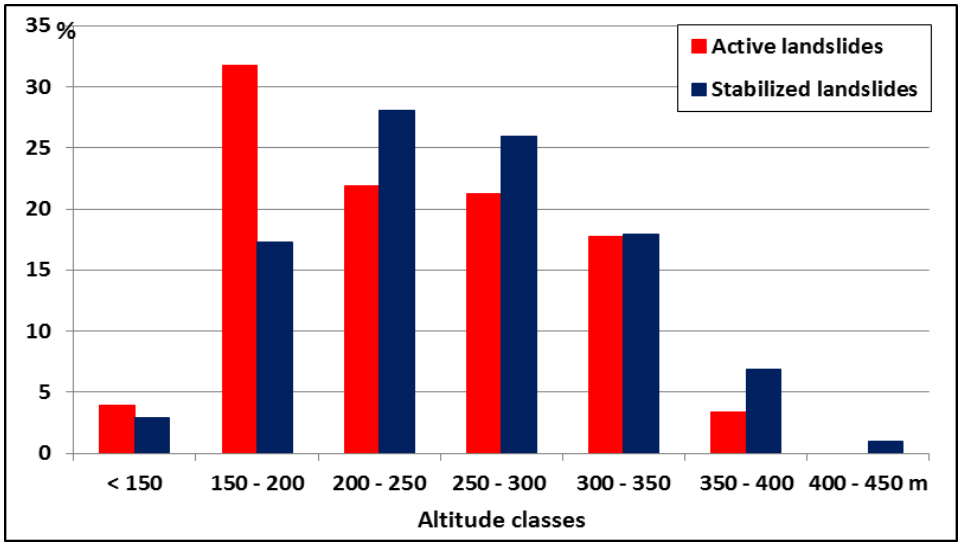

Figure 2: Landslides distribution by the altitude classes

The mean value of slopes in the Stavnic catchment is 14.4%. The land with slope under 18% is dominant, but more limited very steep land is usually located on the cuesta fronts, where the value of slope exceeds 27%.

Figure no. 3 shows that over 90% of landslides occur on land with slope of more than 9%. Thereby, 31% of the active landslides are found on land with slope over 27%, and 42% of the stabilized landslides occur on land with slope of 9-18%, including the degraded back slopes, too.

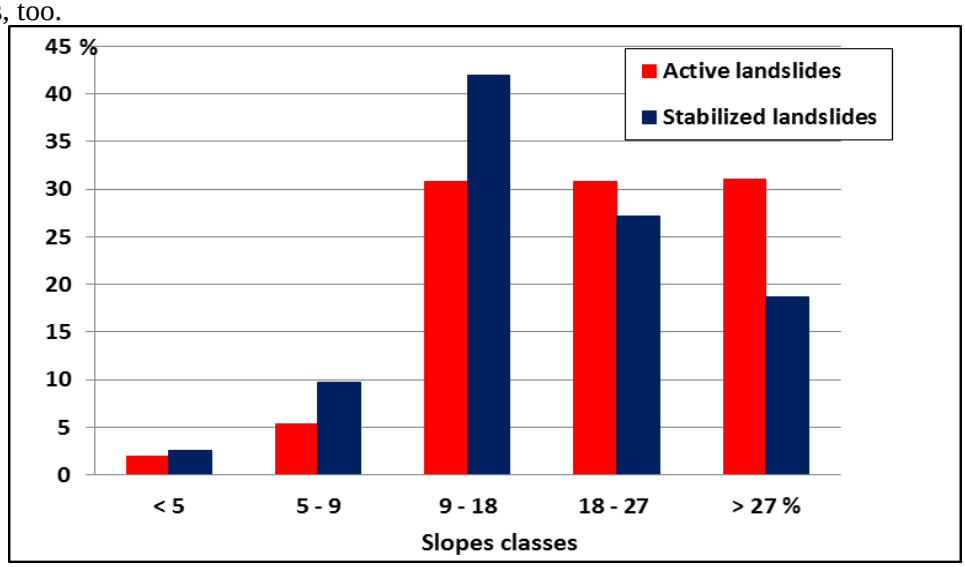

Figure 3: Landslides distribution by slope classes

Figure 4 illustrates the area occupied by the landslides depending on the exposition of the land. In the study area, it is obvious that most landslides occur on prevailing northern and western facing, which are actually cuesta fronts (*Ioniţă I. 2000b*). Pujină D. (2008) claims that "analyzing the slope facing in relation with the monocline structure in the Moldavian Platform it was noticed that the slopes of the subsequent and occasionally of the consequent valleys, through cuesta with predominantly northern and western orientation, provides the most favorable conditions to the landslide development and the associated processes".

Thus, the most significant share of the landslides was identified on the north-eastern looking land, namely 22.7% of the active landslides and 17.9% of the stabilized landslides (Figure 4).

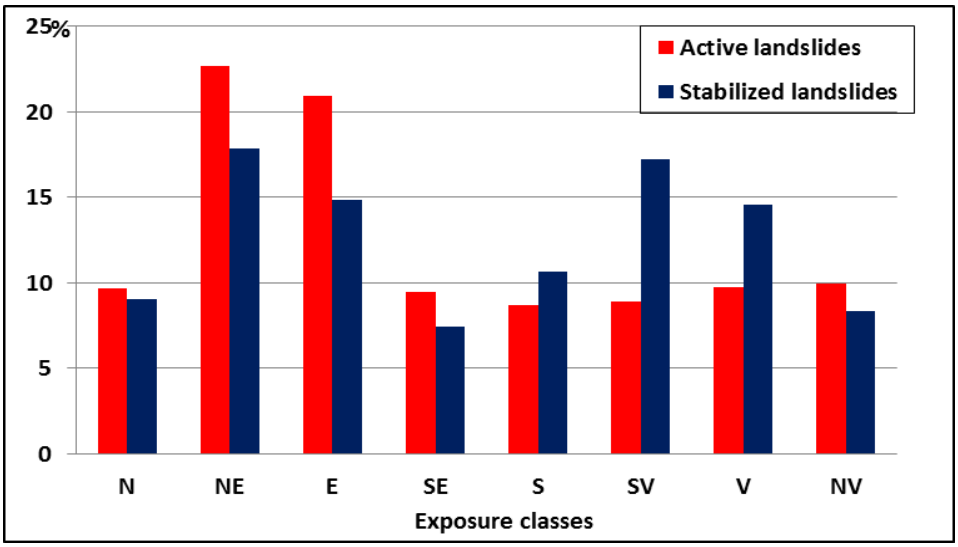

Figure 4: Landslide distribution by exposure classes

A significant share of the landslides developed on the predominantly south (19.3%) or eastern (35.7%) facing slopes can be observed, which usually represent cuesta back slopes. That feature underlines the great magnitude of the land degradation within the Stavnic catchment (Figure 5).

Figure 5: Active landslide on the border of the right valley-side (eastern looking cuesta backslope) and in the left valley-side (western facing cuesta front-foreground) in the upper Stavnic catchment (25.10.2012).

These landslides are mainly triggered by deepening and meandering of the river channel and the undermining of the base-of-slopes.

Generally, taking into account prevailing of the clayey formations, the landslides are characterized by slight diluvium of 1-5 m or middle thickness of 5 - 10 m. As examples of deep seated active landslides there are mentioned the „*La prăpastie*" landslide, located on the Urşiţa cuesta front, northern looking, or that one within the Hadâmbu village. Over there regressive landslides have developed by the deepening of the preexistent gullies and the undermining of their banks.

4. Conclusions

Landslides represent the most important process of land degradation within the Stavnic catchment and covers 12,006 ha, respectively 56% of the total area. Of these, 97% are stabilized landslides, and only 3% are active.

Landslides occur exclusively on the clayey formations, with sandy intercalations of Middle Sarmatian (Bessarabian). The great majority of the landslides are found on the land with 150-350 m altitude.

On the other hand, 31% of the active landslides are found on land with slope over 27%, and 42% of the stabilized landslides occur on land with slope between 9-18%. As to the relation with the exposition, most of landslides and the highest density of them are reported on the NE and E facing slopes.

References

1. Băcăuanu V., Barbu N., Pantazică M., Ungureanu Al., Chiriac D. (1980) – *Podişul Moldovei. Natură, om, economie*, Editura Ştiinţifică şi Enciclopedică, Bucureşti.
2. Donisă I., Boboc N., Ioniţă I. (2009) – *Dicţionar geomorfologic cu termeni corespondenţi în limbile Engleză, Franceză şi Rusă*, Editura Universităţii "Alexandru Ioan Cuza", Iaşi.
3. Ioniţă I. (1998) - *Studiul geomorfologic al degradărilor de teren din bazinul mijlociu al Bârladului*, Teză de doctorat, Universitatea "Al. I.Cuza" Iaşi
4. Ioniţă I. (2000a) – *Relieful de cueste din Podişul Moldovei*, Editura Corson, Iaşi.
5. Ioniţă, I. (2000b) - *Geomorfologie Aplicată. Procese de degradare a terenurilor deluroase*, Editura Universităţii "Alexandru Ioan Cuza", Iaşi.
6. Jeanrenaud P. (1961) – *Contribuţii la geologia Podişului Central Moldovenesc*, An. şt. Univ. Iaşi, s.II, t.VII. 7.2.
7. Jeanrenaud P. (1971) – *Geologia Moldovei centrale dintre Siret şi Prut*, Rezumatul tezei de doctorat, Iaşi.
8. Jeanrenaud P., Saraiman A. (1995) – *Geologia Moldovei Centrale dintre Siret și Prut*, Editura Universităţii "Al. I. Cuza" Iaşi.
9. Pujină D. (2008) – *Alunecările de teren din Podişul Moldovei*, Editura Performantica, Institutul Naţional de Inventică, Iaşi.
10. Ursu A., Vasiliniuc I., Rusu C., Stângă I.C., Niacşu L. (2007) – *Studiul alunecărilor de teren ca factor de risc în bazinul Bârladului cu ajutorul SIG*, în *Impactul riscurilor hidro-climatice şi pedo-geomorfologice asupra mediului în bazinul Bârladului*, Editura Univ. „Al. I. Cuza", Iaşi, Rusu C. coord.
11. *** (2007) *Impactul riscurilor hidro-climatice şi pedo-geomorfologice asupra mediului în bazinul Bârladului*, Editura Univ. „Al. I. Cuza", Iaşi, Rusu C. coord.